Before the

Federal Communications Commission

Washington, D.C. 20554

In the Matter of	)	
	)	
Amendment of Part 97 of the	)	
Commission's Rules Governing	)	RM-8737
the Amateur Radio Service to	)	
Facilitate Spread Spectrum	)	
Communication	)	

To: The Commission

REPLY COMMENTS OF THE RADIO AMATEUR SATELLITE CORPORATION

Introduction

The Radio Amateur Satellite Corporation (AMSAT) is a not-for-profit District of Columbia corporation established in 1969. It is the principal membership organization of the amateur-satellite community in North America. Our current membership is approximately 7,500. Together with more than 30 of our affiliated organizations throughout the world, we have constructed, launched and operated over two dozen satellites to date in the Amateur-satellite Service, of which the majority are presently in operation. These currently operational spacecraft include high-altitude, Molniya-type orbit transponder satellites capable of sustaining two-way communication over terrestrial paths well in excess of 10,000 miles (AMSAT-OSCAR 10 and AMSAT-OSCAR 13), numerous low-earth-orbit (LEO) digital store-and-forward packet radio satellites, scientific and educational payload satellites, LEO analog transponder satellites, and several spacecraft featuring combinations of these types of payloads.

Summary

1. AMSAT has major reservations concerning the Petition for Rule Making ("the Petition") filed by the American Radio Relay League (ARRL) December 12, 1995. We are wholeheartedly in favor of developing new technology in the Amateur and Amateur-satellite services; however we are concerned that the widespread use of spread spectrum techniques with no frequency restrictions will cause major interference to satellite operation and weak signal terrestrial work. Therefore, we urge that the Commission's relaxation of the spread spectrum Rules, as proposed in the Petition, be accomplished only within specific frequency segments within the Amateur and Amateur-satellite bands, with spreading factor limits as will be discussed later. Otherwise, widespread use of spread spectrum by amateur operators, which we hope will occur, can make reception of the relatively weak signals from amateur satellites all but impossible in many parts of the country, particularly in heavily populated regions of the U.S.

2. In support of this contention, we submit both calculations made relative to spread spectrum signal levels and the ARRL's own statements with regard to potential interference which spread spectrum might cause.

Discussion

3. To obtain a measure of the possible interference that could result from only a single spread spectrum station, the following parameters are assumed:

Case I: Line-of-sight propagation

Spread spectrum station with an effective power of 100 watts ERP = +20 dBW
If spread over 10 MHz: -50 dBW/Hz

Free-space attenuation at 20 km from the spread spectrum station at 435 MHz = -110 dB
Spread spectrum signal at 20 km = -160 dBW/Hz
A receiver with a 1 dB NF (common in satellite & weak signal work) = -203 dBW/Hz

Thus, a single spread spectrum station could raise the noise floor at that receiver on the order of 40 dB.

Case II: Propagation over partially obstructed terrain

Parameters similar to *Case I* except that the attenuation (at 20 km) may be as much as 20-30 dB greater, i.e., -130 to -140 dB. In this case, a single spread spectrum station could raise the noise floor at that receiver on the order of 10-20 dB.

One can use these calculations to cite other scenarios:

4. For example, if the spread spectrum station had a power of only 1 watt ERP, this is 20 dB less, yet under line-of-sight conditions, the noise floor would still be on the order of 20 dB higher because of its presence. Over flat terrain and in the absence of intervening obstructions, line-of-sight propagation over a distance of 20 km would require the height above average terrain of only 6 meters for both antennas, or for one antenna of approximately 20 meters with the other at ground level. Many existing amateur repeater and packet node sites, which would be available for spread spectrum service, are on mountaintops or tall buildings hundreds of meters above average terrain and offer line-of-sight transmission over distances well in excess of 20 km.

5. Similar calculations for other distances can also be done. For example, the spread spectrum signal would be 20 dB stronger at a 2 km distance. As another example, a 100 watt transmitter and 10 dB gain antenna could create 10 dB more interference. Obviously, if the spread spectrum station is in close proximity to the satellite earth station or terrestrial weak

signal station, the degradation from the spread spectrum station's operation would be much greater.

6. The requirement for automatic power control of stations using transmitters over 1 watt would not seem to alleviate interference unless ALL spread spectrum stations they contacted were prepared to transmit the data required by the power control scheme. The transmitting station couldn't guess the required power within the plus-or-minus 5 dB accuracy effectively required without some feedback from the distant receiver.

7. In addition, if spread spectrum techniques are employed by amateur satellites or terrestrial full-duplex repeater stations, the automatic power control aspects of the Petition may prove to be unworkable. A satellite transponder is a shared resource, and digital amateur earth stations using it generally employ a Carrier Sensed Multiple Access technique to share the uplink channel. If the satellite transmitter were required to adjust its power to achieve a 23 dB signal-to-noise ratio for each successive using station in the typical time-interleaved operation, other users would not be able to hear many of the satellite's transmissions, and thus transmit at times that would cause interference. The same problem would occur in terrestrial full-duplex repeater operation.

8. It might be said that antenna directivity would account for a significant modification of this situation. AMSAT contends that with increases in the noise floor as great as these cited, antenna directivity cannot be counted upon for a significant improvement. Only if the if the increases in the noise floor were in the order of 5 to 10 dB might antenna directivity be counted on to provide such protection. However, few amateur-satellite earth stations, or even terrestrial weak signal operators, have antennas with side

lobes down 30 dB. In addition, there are many instances in which antennas being used to receive amateur satellites are pointed near the horizon rather than being elevated. Amateur LEO satellites, for example, are typically below 10 degrees elevation at lease half the time during which they are within range of a given earth station. Of course, antennas for terrestrial work are always pointed at the horizon. In these cases, there is no improvement from using directive antennas if an interfering spread spectrum station is in the same direction as the desired satellite or terrestrial station.

9. In addition to terrestrial operation by amateurs using weak signal techniques, a significant number employ Earth-Moon-Earth (EME) communications. A "typical" 432 MHz EME station might employ a transmitter with 1 kilowatt output and an antenna with a gain of 26 dBi and 1 dB transmission line loss. Assuming two such stations communicating with each other, the received signal strength for each would be about -180 dBW. Many EME stations have even less power and lower antenna gains than this example. Obviously, because of the extremely low received signal strengths involved in EME operation, any increase in noise floor would render successful communications impossible. Therefore, significant use of spread spectrum, which might include 432 MHz would eliminate EME as a viable mode on that band.

10. The ARRL in Para. 9 of the Petition goes to some length to state that "unintentional triggering of repeater inputs" is not considered to constitute interference, and that therefore this section of the Rules [(7-311(b)] should be deleted. It appears to AMSAT that this is prima facie evidence that ARRL believes that spread spectrum operation will result in noise floor increases sufficient to trigger FM repeaters. If this is the case, we

contend that such a noise floor increase would certainly be sufficient to drastically degrade reception of weak satellite, terrestrial or EME signals.

AMSAT's Proposal

11. AMSAT believes that spread spectrum operation should be encouraged. We believe that it will eventually prove valuable for both terrestrial and satellite applications. However, we contend that it should be restricted to certain frequency segments so as to offer minimal interference to other satellite, EME or terrestrial operation, while still allowing experimentation. We contend that this is consistent with Commission policy in the Amateur Service. We cite, as examples, the fact that voice operation has been limited to certain segments in the HF and VHF amateur bands for many years. In addition, unattended digital operation is restricted to certain small segments in the HF bands.

12. In particular, AMSAT contends that spread spectrum should not normally be allowed below 450 MHz. We are aware that the current rules allow spread spectrum operation above 420 MHz, and have since 1985. It may be argued that the fact that spread spectrum has been authorized in the 420 - 450 MHz band for over ten years, with no reports of interference recorded, proves that it poses no threat to satellite operation, EME or weak signal terrestrial work. However, AMSAT cites ARRL's own words in Para. 2 of their Petition from which we quote:

> "Since the time spread spectrum communications were first authorized in the Amateur Service in mid-1985, there have been some experimental amateur operations using spread spectrum techniques, but its use has not been widespread."

13. AMSAT believes that this is an understatement and that spread spectrum use has been extremely limited. We submit that this is the reason why no interference complaints

have been registered. Furthermore, AMSAT has seen no reports of tests conducted by those amateurs who were experimenting with spread spectrum that address its potential interference to satellite operation and other weak signal modes.

14. AMSAT would like to see spread spectrum develop. We would like to see it become a major factor in Amateur Radio, including its potential role of opening the microwave bands to greater amateur operation. However, we contend that, while it may be compatible with relatively high signal strength narrow-band modes such as FM repeaters and terrestrial packet, it is not compatible with relatively weak signal modes such as amateur-satellite operation and terrestrial weak signal work.

15. In order to allow it to fulfill its potential and still protect these other types of operation, AMSAT strongly recommends that spread spectrum be authorized only in the following segments of the Amateur and Amateur-satellite bands:

905 - 928 MHz

1240 - 1260 MHz

2410 - 2450 MHz

3300 - 3445 MHz

All bands above 5500 except 5750 - 5770 MHz and 10.360 - 10.380 GHz.

16. Following this course will protect amateur-satellite operation in the 435 - 438 MHz, 1260 - 1270 MHz (uplink only) and 2400 - 2410 MHz bands and still permit its use in the bands 2410 - 2450 and all the higher bands authorized for the Amateur-satellite Service. These proposed frequencies also provide protection for existing weak signal terrestrial and EME operation near 432, 902, 1296, 2304, 3456, 5760 and 10,368 MHz.

17. AMSAT further recommends that the Commission require spreading ratios of 100 to 1000 in order to reduce the power density of the spread spectrum signals. This would not only reduce interference to non-spread spectrum users but also interference to spread spectrum users from narrow-band signals.

18. We recognize that, from time to time, technically advanced amateurs may wish to experiment with spread spectrum techniques specifically intended for weak-signal applications such as satellites and EME. AMSAT wishes to encourage such experimentation by those qualified to do so, but due to the potential interference problem discussed above, we recommend that if such experiments must be carried out below 450 MHz or within the Amateur-satellite service frequency allocations or the commonly used weak-signal sub-bands above 450 MHz, that they be specifically authorized, for limited periods of time, under Special Temporary Authority.

Conclusion

19. AMSAT urges the Commission to incorporate these recommendations in formulating new spread spectrum rules designed to foster its widespread use among amateur radio operators. We further recommend that it place no greater restrictions on spread spectrum use, such as station identification and authorized spreading codes, than absolutely necessary. We contend that such a course will foster growth of spread spectrum among amateurs and allow them to continue in their traditional pursuit of new technologies and the use of higher and higher frequencies, while not disrupting other valuable amateur operation.

RESPECTFULLY SUBMITTED,

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By William A. Tynan
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